tabulated in the fourth column, it appears that the effect of the current is to increase the retraction very slightly.

According to Rowland the susceptibility of cobalt is *increased* by heating. The small additional retraction indicated when the current was passing was, therefore, no doubt due to the increased suscepti-bility consequent upon current heating. It may be noted that tension seems to have no material effect upon the magnetic retraction of cobalt.*

Summary.

In an iron wire carrying a current, the maximum magnetic elonga-tion is greater, and the retraction in strong fields is less, than when no current is passing. The effect of the current is opposite to that of tension.

The magnetic retractions of nickel and of cobalt are not sensibly affected by the passage of a current through the metals. (Tension considerably modifies the magnetic retraction of nickel, but not that of cobalt.)

III. " On the Measurement of the Magnetic Properties of Iron." By THOMAS GRAY, B.Sc., F.R.S.E. Communicated by LORD KELVIN, P.R.S. Received May 3, 1892.

(Abstract.)

This paper gives the method of experiment and results obtained in some investigations on the time-rate of rise of current in a circuit having large electromagnetic inertia. The experiments were made on a circuit containing the coils of a large electromagnet having laminated cores and pole pieces. The mean length of the iron circuit was about 250 cm. and its cross section 320 sq. cm. The magnetising coil had 3840 turns, when all joined in series, and a resistance of 10·4 ohms. The coils were so arranged that they could be joined in a variety of ways so as to vary the resistance, inductive coefficient, &c., and also to allow the magnet to be used either as an open or a closed circuit transformer.

The electromotive force used in the experiments was obtained from a storage battery, and the method of experiment was to trace the curve, giving the relation of current to time, on a chronograph sheet.

One set of experiments shows the effect of varying the impressed E.M.F. on the time required for the current to attain any given per-centage of its maximum strength. The results show that for any particular percentage there is always a particular E.M.F. which takes

* *Loc. cit.*

maximum time.   Thus for the circuit under consideration, and with successive repetitions of the current in the same direction, it takes longer time for the current produced by an impressed E.M.F. of 4 volts to reach 95 per cent. of its maximum than it takes for the current produced by either 3 or 5 volts to reach 95 per cent. of their maximum.   The results show also that, within considerable limits, the time required for the current to become uniform is on the whole nearly inversely proportional to the impressed E.M.F., and that for moderate values of the E.M.F. the time may be very great; when the E.M.F. was 2 volts, and the current sent in such a direction as to reverse the magnetism left in the magnet by a previous current of the same strength, the time required for the current to establish itself was over three minutes.   The difference of time required for repetition and for reversal of previous magnetisation was also very marked when the iron circuit was closed.   The results show that great errors may arise by the use of ballistic methods of experiment, especially when weak currents are used, and that for testing resistances of circuits containing electromagnets, a saving of time may be obtained by using a battery of considerable E.M.F.

Another set of experiments gives the effect of successive reversals of the impressed E.M.F. at sufficient intervals apart to allow the magnetisation to be established in each direction before reversal began.   In this set also the effect of cutting out the battery and leaving the magnet circuit closed is illustrated, showing that several minutes may be required for the magnet to lose its magnetism by dissipation of energy in the magnetising coil.   The effect on these cycles of leaving an air space in the iron circuit is also illustrated. It is shown that a comparatively small air space nearly eliminates the residual magnetism and diminishes considerably the rate of variation of the coefficient of induction and the dissipation of energy in the magnet.

Several cycles are shown for the magnet used as a transformer with different loads on the secondary.   The results give evidence that there is less energy dissipated in the iron the greater the load on the secondary of the transformer.

Some experiments are also quoted which go to show that the dissipation of energy due to magnetic retentiveness (magnetic hysteresis) is simply proportional to the total induction produced when the measurements are made by kinetic methods.   Reference is made to the recent experiments of Alexander Siemens and others which seem to confirm this view.